NASA TECHNICAL TRANSLATION NASA TT F-14,748

HOLOGRAPHIC DIFFRACTION GRATINGS AND THEIR APPLICATIONS

G. Pieuchard, J. Flamand, J. Cordelle
A. Labeyrie

(NASA-TT-F-14748) HOLOGRAPHIC DIFFRACTION GRATINGS AND THEIR APPLICATIONS (NASA) 6 p HC $4.00 CSCL 20E

N74-22173

Unclas
G3/16 37882

Translation of: "Les reseaux holographiques & leurs applications", extract from Les Applications de l'Holographie, Comptes rendus du Symposium International, Besancon, July 1970, 4 pages.

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
WASHINGTON, D.C. 20546 SEPTEMBER 1973

HOLOGRAPHIC DIFFRACTION GRATINGS AND THEIR APPLICATIONS

G. Pieuchard, J. Flamand, J. Cordelle†
A. Labeyrie††

In a number of previous articles [see References] we have discussed the general properties of plane and concave holographic diffraction gratings. We will give a brief review of these properties, and discuss at greater length experimental achievements and possible applications of these new optical components. /2*

PRINCIPLES OF METHOD- GENERAL PROPERTIES

The grooves in the grating correspond to equiphase lines being the intersections between a volume of interferences and the surface of the light-sensitive receiving layer. A chemical treatment confers grooved relief upon these lines, and by subsequent vacuum metallization we obtain a reflection grating.

The very principle of the method avoids periodic or random ruling errors; thus ghosts never appear and the diffused light content is extremely low. The quality of the diffracted wave surfaces depends only on the quality of waves interfering with recording and the quality of the sensitive substrates. We are presently obtaining wave surface qualities of 1/4 on average-sized gratings.

We have shown theoretically, and confirmed by experiment, that it is possible to record concave gratings with anastigmatic properties unknown in classical gratings. In general, there are three absolutely anastigmatic points which can be moved around at will in the spectrum.

*Numbers in right hand margin indicate pagination of foreign text.
†JOBIN-YVON Society, 26 rue Berthollet, 94, Arcueil (France).
††PARIS-MEUDON Observatory, 92, Meudon (France).

Finally, it is possible to achieve plane or concave gratings /3
diffracting waves which are deformed in a predetermined manner: for example, a Schmidt blade shaped wave, which enables spherical aberration to be corrected.

ACHIEVEMENTS

- The size of manufactured gratings reaches 300 mm in both the plane and concave varieties.
- The density varies from 1200 lines/mm to 3600 lines/mm.
- Efficiency reaches 40% to 50% in natural light, and 60% to 70% in polarized light for gratings with between 1200 and 2400 lines/mm.

These efficiencies can be achieved for wave lengths between 2500 Å and one micron.

- These gratings have marked polarizing effects; the efficiency curves are in general fairly flat over several thousand angströms.
- On medium-sized gratings (140 mm) we have reached resolutions practically equal to theoretical resolutions.

APPLICATIONS

- In the case where the absence of diffused light is very important, Raman spectroscopy, we found that use of a single holographic grating gave results similar to those obtained with a double monochromator.
- The use of concave gratings with anastigmatic points must permit production of spectrographs with interesting characteristics, particularly with respect to the aperture and correction of aberrations. We are presently testing such a spectrograph operating at f/1 in the image medium f/15 in the object medium

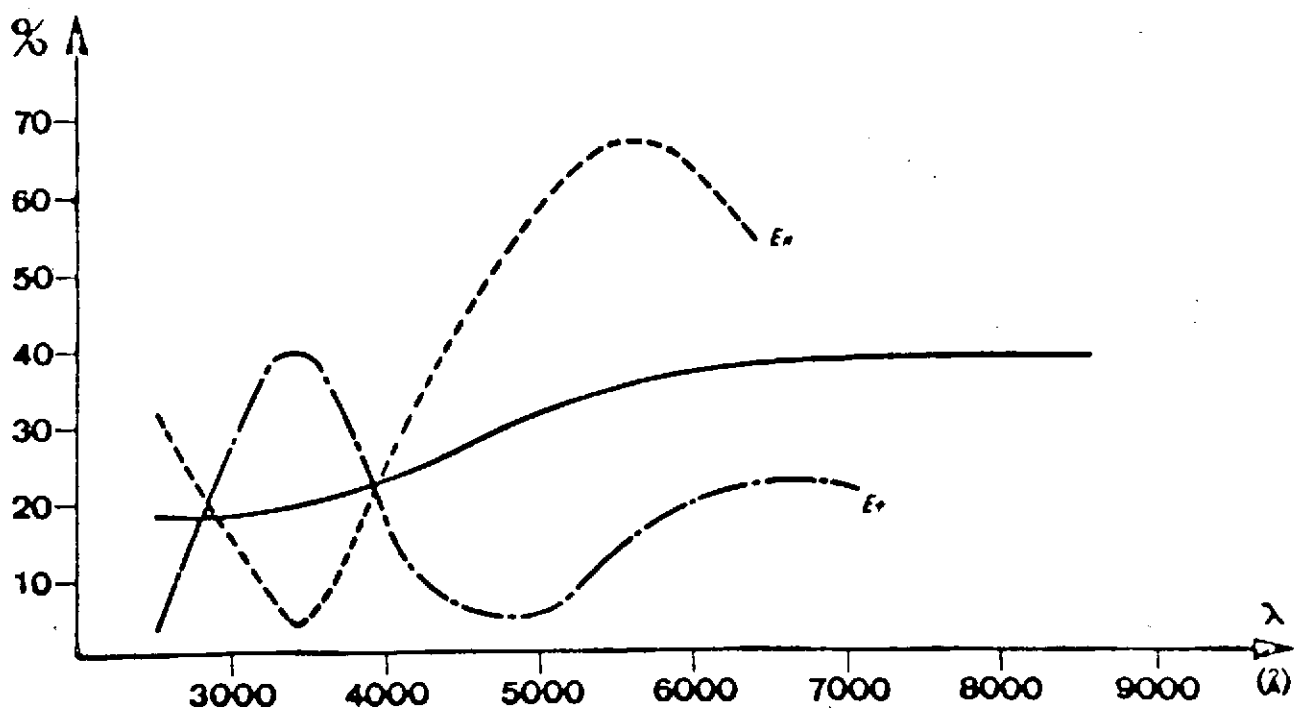
which, over a spectral interval of 1500 Å, will probably replace classical wide-aperture astronomical spectrographs made by a plane grating and a Schmidt chamber.

We have shown theoretically and confirmed by experiment that /4
it was possible to construct, holographically, a monochromator made of a single concave grating revolving around its vertex. This arrangement provides only modest resolutions, but operates over a broad spectral range.

Finally, we are looking at the possibility of using concave gratings with anastigmatic points as optical elements to create an image. The first tests are encouraging, and are leading us to make a theoretical study of such systems.

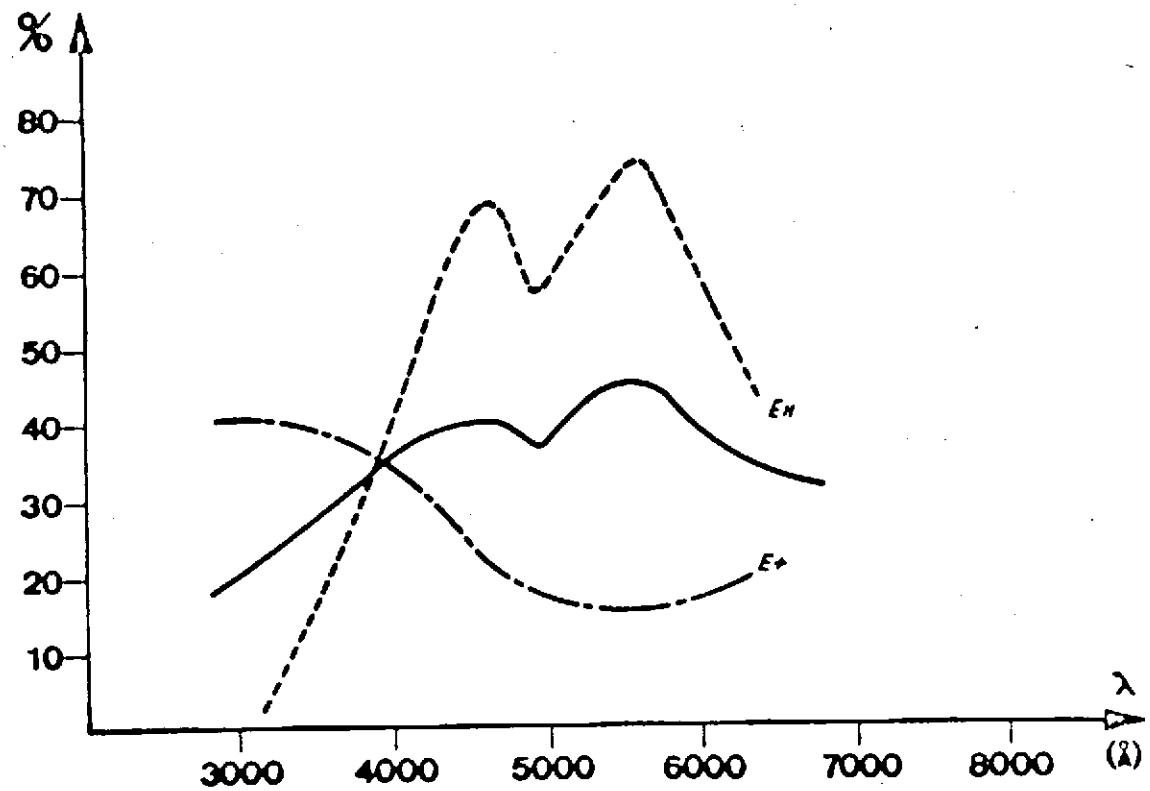
ABSOLUTE EFFICIENCY

HOLOGRAPHIC DIFFRACTION GRATING 1200 Rulings/mm



ABSOLUTE EFFICIENCY

HOLOGRAPHIC DIFFRACTION
GRATING 2400 Rulings/mm



SPECTRAL EFFICIENCY CURVES OF HOLOGRAPHIC DIFFRACTION GRATINGS

REFERENCES

Cordelle, J., Flamand, J., Pieuchard, G. and Labeyrie, A.: Aberration corrected concave gratings made holographically—Optical Instruments and Techniques: To be published.

Cordelle, J.: Holographic Diffraction Gratings, ATOMS, No. 271, December 1969, vol. 24, p. 763.

Labeyrie, A. and Flamand, J.: Spectrographic performance of Holographically made diffraction gratings—Optics Communication, vol. no. 1, April 1969.

Pieuchard, G., Flamand, J., Cordelle, J. and Labeyrie, A.: Holographic Diffraction Gratings, ATOMS , No. 271, December 1969, vol. 24, p. 763.